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Detecting the Dynamics of Heavy Precipitation Vb-Cyclones Under Climate Change Using Neural Networks (Young Scientist Travel Award)

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Heavy precipitation and floods, triggered by large scale atmospheric drivers, are of high societal importance. Scientific knowledge on the climatology of heavy-precipitation related cyclones and the effects of climate change on their dynamics is still limited, especially due to the uncertainty of internal variability. An improved understanding of the role of internal variability can be supported by the analysis of large initial-conditions ensembles of a single climate model.

The ClimEx project (Climate Change and Extreme Events, www.climex-project.org) has developed an initial-conditions 50-member ensemble (CRCM5-LE) at 12-km resolution by dynamically downscaling a single-model ensemble of the CanESM2 global climate model with the Canadian Regional Climate Model (CRCM5) over two domains, northeastern North America and Europe. The Representative Concentration Pathway (RCP) 8.5 is used as external forcing. This dataset enables the assessment of climate change effects on meteorological and hydrological extreme events while considering internal climate variability as an important underlying uncertainty.

To address the major challenges involved in analyzing the big data of such an ensemble for hydrometeorological extremes a machine learning approach for pattern recognition was employed. An artificial neural network was trained to specifically and efficiently detect weather patterns and extra-tropical cyclones, which are associated with heavy precipitation.

We present this artificial neural network approach for the synoptic situation of a cut-off low over Central Europe and its concomitant cyclone of type Vb – a rare cyclone type that has triggered several devastating floods in the study area of Bavaria. Our results demonstrate the performance of the procedure and its capacity to detect historic Vb-events in a reanalysis-driven model run. Using the large ensemble, the particular relevance of considering internal variability in climate change impact assessment is highlighted by presenting the ratio between climate change signal and internal noise. Finally, the long-term effects of climate change are illustrated in terms of higher frequencies, shifting seasonality and increasing precipitation rates related to Vb-cyclones.

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